

Claims

[c1] 1. An electrochemical cell comprising:

- a membrane electrode assembly (MEA) comprising a first electrode, a second electrode, and a membrane disposed between and in fluid communication with the first and second electrodes;
- a first cell separator plate disposed on the first electrode side of the MEA and defining a first flow field therebetween, the first flow field proximate a first frame member;
- a second cell separator plate disposed on the second electrode side of the MEA and defining a second flow field therebetween, the second flow field proximate a second frame member; and
- a carbon layer with integrated flowchannels disposed at the first flow field;

wherein the flowchannels have a flow width that is equal to or less than the width of the webbing between adjacent flowchannels.

[c2] 2. The electrochemical cell of Claim 1, wherein the carbon layer is compatible with a hydrogen environment, and has an electrical resistivity of equal to or less than

about 0.73 Ohm-centimeters.

- [c3] 3.The electrochemical cell of Claim 2, wherein the carbon layer has an electrical resistivity of equal to or less than about 0.73 Ohm-centimeters at a compressive load at the carbon layer of about 100 pounds-per-square-inch.
- [c4] 4.The electrochemical cell of Claim 1, further comprising:
 - a pressure pad disposed between the first cell separator plate and the carbon layer sufficient to maintain a surface pressure at the MEA of equal to or greater than about 150 pounds-per-square-inch.
- [c5] 5.The electrochemical cell of Claim 4, wherein the pressure pad consists essentially of compressible carbon.
- [c6] 6.The electrochemical cell of Claim 1, wherein the carbon layer is compressible sufficient to maintain a surface pressure at the MEA of equal to or greater than about 150 pounds-per-square-inch.
- [c7] 7.The electrochemical cell of Claim 1, wherein the carbon layer is absent metal or metallic plating.
- [c8] 8.The electrochemical cell of Claim 1, wherein the carbon layer comprises carbon paper, carbon sheet, carbon

cloth, or any combination comprising at least one of the foregoing.

- [c9] 9. The electrochemical cell of Claim 1, wherein the carbon layer is porous and is in intimate contact with the MEA, the porosity being sufficient for the diffusion of gas and liquid.
- [c10] 10. The electrochemical cell of Claim 1, wherein the first frame member is absent fluid flow channels.
- [c11] 11. The electrochemical cell of Claim 1, wherein the carbon layer is an assembly comprising:
 - a first layer having first fluid flowchannels oriented in a first direction; and
 - a second layer having second fluid flowchannels oriented in a second different direction;wherein the first and second fluid flowchannels of the assembly permit lateral and longitudinal flow therethrough.
- [c12] 12. The electrochemical cell of Claim 11, wherein the first fluid flowchannels, the second fluid flowchannels, or both, are pierced through the first and the second layer, respectively.
- [c13] 13. The electrochemical cell of Claim 11, wherein the first fluid flowchannels, the second fluid flowchannels, or

both, are embossed into the material of the first and the second layer, respectively.

- [c14] 14. The electrochemical cell of Claim 1, wherein the flowchannels extend to the edge of the carbon layer.
- [c15] 15. The electrochemical cell of Claim 6, wherein the carbon layer is compressible sufficient to maintain a surface pressure at the MEA of equal to or greater than about 150 pounds-per-square-inch at a compression amount at the carbon layer of equal to or greater than about 15% of its initial thickness.
- [c16] 16. The electrochemical cell of Claim 1, further comprising:
a porous support plate disposed between the MEA and the second cell separator plate.
- [c17] 17. The electrochemical cell of Claim 1, further comprising:
a first gasket disposed between the first frame member and the MEA, and a second gasket disposed between the second frame member and the MEA, the gaskets suitable for gas and liquid sealing.
- [c18] 18. The electrochemical cell of Claim 1, further comprising:
a porous carbon gas diffusion layer (GDL) disposed be-

tween the carbon layer and the MEA.

- [c19] 19. The electrochemical cell of Claim 18, wherein the GDL is compressible sufficient to maintain a surface pressure at the MEA of equal to or greater than about 150 pounds-per-square-inch.
- [c20] 20. The electrochemical cell of Claim 18, wherein the GDL has an electrical resistivity of equal to or less than about 0.73 Ohm-centimeters at a compressive load at the GDL of about 100 pounds-per-square-inch.
- [c21] 21. The electrochemical cell of Claim 18, wherein the GDL comprises carbon paper, carbon sheet, carbon cloth, or any combination comprising at least one of the foregoing.
- [c22] 22. The electrochemical cell of Claim 18, wherein the carbon layer and the GDL each consist essentially of carbon.
- [c23] 23. An electrochemical cell comprising:
 - a membrane electrode assembly (MEA) comprising a first electrode, a second electrode, and a membrane disposed between and in fluid communication with the first and second electrodes;
 - a first cell separator plate disposed on the first electrode side of the MEA and defining a first flow field therebetween, the first flow field proximate a first frame mem-

ber;

a second cell separator plate disposed on the second electrode side of the MEA and defining a second flow field therebetween, the second flow field proximate a second frame member; and

a porous carbon gas diffusion layer (GDL) disposed at the first flow field and in intimate contact with the MEA; wherein the GDL has an electrical resistivity of equal to or less than about 0.73 Ohm-centimeters at a compressive load at the GDL of about 100 pounds-per-square-inch.

- [c24] 24. The electrochemical cell of Claim 23, wherein the GDL is compressible sufficient to maintain a surface pressure at the MEA of equal to or greater than about 150 pounds-per-square-inch.
- [c25] 25. The electrochemical cell of Claim 23, wherein the GDL consists essentially of compressible carbon.
- [c26] 26. The electrochemical cell of Claim 23, wherein the GDL is porous and is in intimate contact with the MEA, the porosity being sufficient for the diffusion of gas and liquid.
- [c27] 27. The electrochemical cell of Claim 23, wherein the GDL is compressible sufficient to maintain a surface pressure

at the MEA of equal to or greater than about 150 pounds-per-square-inch at a compression amount at the GDL of equal to or greater than about 15% of its initial thickness.